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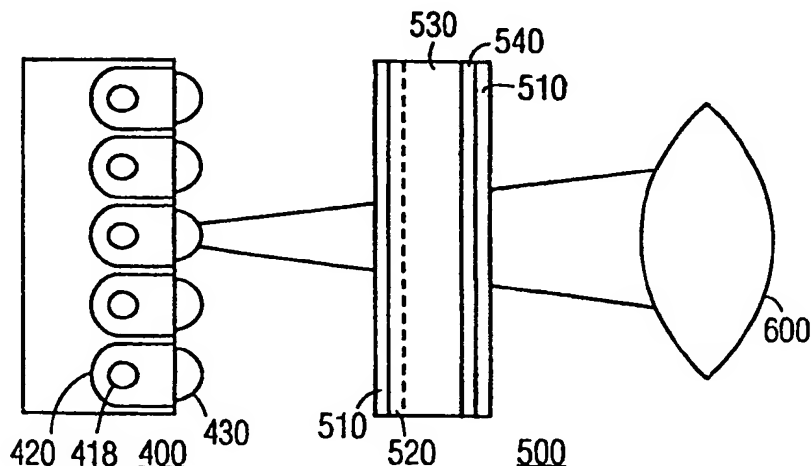
INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(54) Title: FLAT PANEL LIGHT SOURCE FOR LIQUID CRYSTAL DISPLAYS

(57) Abstract

A liquid crystal display is provided using a flat panel of microlamps being formed from gas discharge display structures and made by the method of making the same utilizing integrated circuit fabrication techniques. The flat panel of microlamps is formed into an array for providing light to individual pixels, or a small number of pixels, in a liquid crystal display. Such microlamp lighting can increase the illumination of LCDs.



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Flat panel light source for liquid crystal displays.

The invention relates to a significantly improved liquid crystal display (LCD) having a flat panel of microlamps to provide the light source for the display.

5 The use of a panel of microlamps, according to the present invention, in a flat panel array has been found to be extremely attractive for liquid crystal displays. The array of microlamps according to the present invention enables a higher screen brightness of optical transmission in Active Matrix Liquid Crystal Displays (AMLCDs). Typically, such AMLCDs have an optical transmission of less than 30% because of an array of colour filters and polarizers over the AMLCD. Further, use of TFT arrays in such displays causes a low aperture ratio.

 These problems of conventional AMLCDs require a high intensity light source, particularly in projection systems, in order to obtain a reasonable screen brightness. The array of individual micro-light sources of the present invention solves these problems.

15 The individual microlamps have a reflector integrated with the micro-light source and a microlens to project and focus the light into each pixel or at most several pixels of the LCD. The combined array of individual microlamps provides a large area light display of high intensity light. This significantly improves the use of flat panel LC displays and enables improved projection displays as well as forming a useful area spot lighting arrangement.

20 Accordingly, the present invention is directed to a flat panel light source of microlamps.

 In addition, the present invention is directed to a liquid crystal display having a flat panel light source.

 Further, the present invention is directed to an area lighting scheme using

25 a microlamp arrays.

 In particular, the flat panel light source of the present invention comprises an array of microlamps having a micro-reflector for each microlamp light source cavity directing light through a micro-lens associated with the light source. An array of such microlamps is provided to direct light through a LCD, such as used in projection displays.

Finally, such an array of microlamps according to the present invention is provided as an area lighting scheme.

5 For better understanding of the invention, reference is made to the following drawings which are to be taken in conjunction with the detailed description to follow:

Figure 1 is a cross-sectional view of a microlamp array according to the present invention;

10 Figure 2 is a cross-sectional illustration of a microlamp array directing light to a projection LCD according to the present invention;

Figure 3 is an illustration of a conventional HID lamp for area illumination;

15 Figure 4 shows a microlamp array according to the present invention used for area illumination; and

Figure 5 shows a cross-section of a display device incorporating a microlamp array of the invention.

20 Figure 1 shows a partial cross-section of an array 400 of microlamps according to the present invention. This array has a number of microlamps 440 each formed by individual microlamps of a light source cavity 418, a reflective surface 420 and lens 430. This structure is similar to that found in U.S. patent application Serial No. (1504-0928, PHA 21.987 US) filed the same day as the present application and having common inventors.

25 Such an array of microlamps is used according to the present invention in a projection display, such as the LCD display in Figure 2. In this structure the microlamp array 400, according to the present invention, directs light from each microlamp to a liquid crystal panel 500. The LCD panel is formed of polarizers 510, TFT electrode structure 520, liquid crystal 530 and electrode 540. Images formed in the LC display are projected as light
30 formed from each microlamp 440 through the liquid crystal panel 500 to a projection lens or lens system 600, such as used in projection television devices.

The individual light sources 440 from the array 400 provide high intensity illumination of the liquid crystal display which enhances the final image formed without loss of light as occurs in conventional schemes. That is, the optical transmission of

Active Matrix Liquid Crystal Displays (AMLCD) is typically less than 30%. The use of individual microlamps as light sources for the LCD according to the present invention significantly improves light coupling from the light source into the LC display. Moreover, the individual light sources of the microlamp array of the present invention form an expanded
5 light viewing angle for the LCD since each microlamp can focus light into individual pixels of the LCD or at most only several pixels, providing a significant increase in brightness. Thus, significant increases in the amount of light going through the LCD device occur.

The formation of such microlamp arrays according to the present invention using ultra-violet (UV) light from fluorescent type light can produce significant
10 increases in the use of AMLCDs. Such structures using florescent lighting for the individual microlamp light sources enable the provision of direct view flat panel light sources. The resulting structure then provides improved brightness, uniformity of the light and compactness of the display. The distance between the microlamp light array and the LC panel results in variable viewing angles of the display. A UV flat light source having
15 florescent microlamps without phosphors can be used in such displays. In this instance the colour phosphors for the display are formed in a pattern on the front of the LC panel and the LC modulates the UV light with the phosphor pattern converting the UV into visible light. Such an arrangement would provide a wide viewing angle light display.

Figure 5 shows such a display device 800, in which flat panel light source
20 fluorescent microlamp array 802 emits UV light, indicated by the solid arrows, which UV light is modulated by LC panel 804, indicated by the dashed arrows. The modulated UV light falls on patterned colour phosphor layer 806, containing phosphors which emit visible light, indicated by the solid arrows, upon excitation by the UV light.

Relative to area displays Figure 3 shows a conventional high intensity
25 discharge light source 700 having an HID lamp 710 within a reflector 720. This light source is used to provide area spot lighting. According to the present invention as seen in Figure 4, a microlamp array 400 is formed with a holding luminaire structure 810. Such an arrangement according to the present invention provides a higher lumen output of the lamps. Moreover, the microlamp structure of the present invention enables a predetermined
30 illuminated area to be formed by the design of the optical elements.

The above described structures and methodology are merely illustrative of the principles of the present invention. Numerous modifications and adaptations thereof will be readily apparent to those skilled in the art without departing from the spirit and scope of the present invention and the appended claims.

Claims:

1. A flat panel illumination device comprising an array of microlamps, each of said microlamps including a light source cavity, a reflector and a lens.
2. A lighting arrangement for liquid crystal displays comprising a liquid crystal panel, and an adjacently disposed illumination system including an array of
5 microlamps, each of said microlamps including a light source cavity, a reflector and a lens.
3. An area lighting device comprising an array of microlamps within a luminaire structure, each of said microlamps including a light source cavity, a reflector and a lens.
4. Flat panel display device comprising an ultra violet light emitting
10 microlamp array, a liquid crystal panel positioned in front of the array for modulating the ultra violet light in accordance with a display signal, and a phosphor layer on the front of the liquid crystal panel for converting the modulated ultra violet light into visible light.
5. The flat panel display device of claim 4, in which the microlamp array comprises fluorescent microlamps.
- 15 6. The flat panel display device of claim 4 or 5, in which the liquid crystal panel is an active matrix liquid crystal display (AMLCD) panel.
7. The flat panel display device of claim 4, 5 or 6, in which the phosphor layer comprises a pattern of colour phosphors.

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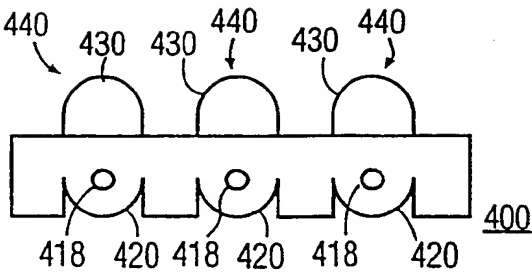


FIG. 1

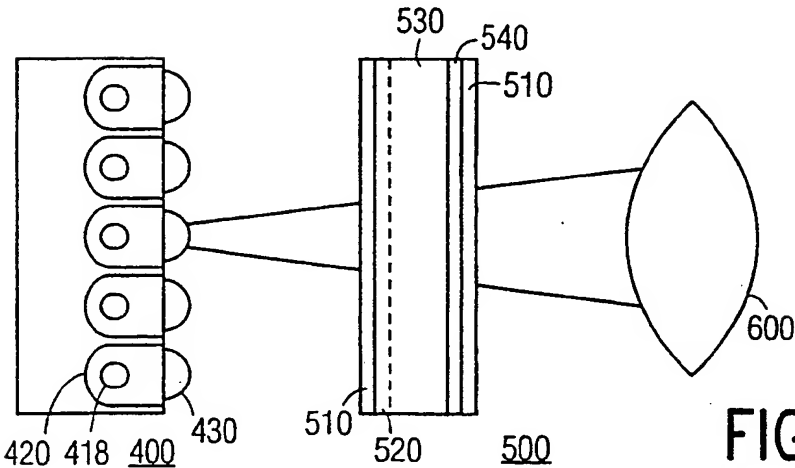


FIG. 2

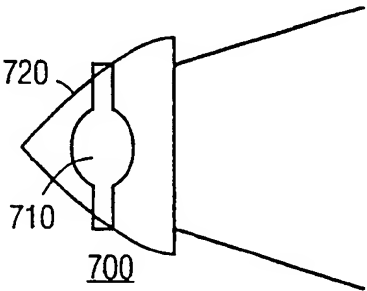


FIG. 3

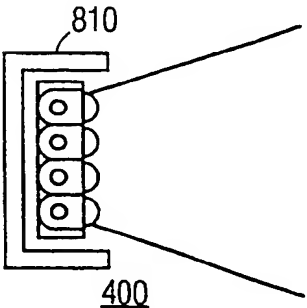
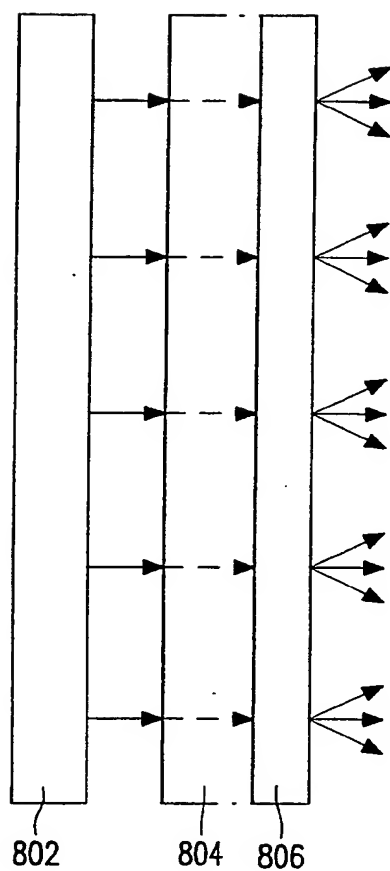


FIG. 4

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800

FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.

PCT/IB 96/00490

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: G09F 9/313, G02F 1/1335

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: G09F, G02F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, CLAIMS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5401966 A (D. F. GRAY ET AL), 28 March 1995 (28.03.95), column 5, line 30 - column 6, line 66, figure 4, abstract --	1,3
A	US 5267062 A (S.A. BOTTORF), 30 November 1993 (30.11.93), column 2, line 23 - column 3, line 62, figures 1-5, abstract --	2,4-7
A	US 5146355 A (J.C. PRINCE ET AL), 8 Sept 1992 (08.09.92), column 4, line 6 - column 5, line 48, figures 1,2, abstract --	2,4-7

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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Date of the actual completion of the international search

18 Sept 1996

Date of mailing of the international search report

23-09-1996

Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/IB 96/00490

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5333073 A (M. SUZUKI), 26 July 1994 (26.07.94), column 3, line 63 - column 4, line 12, figure 1, abstract --	2,4-7
A	GB 2268304 A (MOTOROLA A/S), 5 January 1994 (05.01.94), page 4, line 30 - page 6, line 23, figures 1,2, abstract -- -----	2,4-7

INTERNATIONAL SEARCH REPORT

International application No.

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Box I Observations where certain claims were found unsearchable (Continuation of Item 1 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of Item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

- I. Claims 1 and 3 directed to a lighting device comprising an array of microlamps.
- II. Claims 2 and 4-7 directed to a display device comprising a liquid crystal panel and an illuminating microlamp array.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☒ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
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☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

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Patent document cited in search report		Publication date	Patent family member(s)		Publication date
US-A-	5401966	28/03/95	NONE		
US-A-	5267062	30/11/93	EP-A-	0529832	03/03/93
US-A-	5146355	08/09/92	CA-A-	2000388	14/05/90
			DE-D,T-	68914788	20/10/94
			EP-A,B-	0369730	23/05/90
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			JP-T-	7508105	07/09/95
			US-A-	5499120	12/03/96
			WO-A-	9400793	06/01/94